Transition Experiment

Jenna Eppink and Shelly Sadowski
NASA Langley Research Center

AIAA CFD Transition Modeling DG, Feb. 10, 2022

Objectives

- Test Objectives
  - Provide needed experimental database for transition modelers
  - Next-generation transition models will be used for more efficient designs of fixed-wing aircraft, rotorcraft, and turbomachinery

- Design Objectives (model/flow conditions)
  - Design wing to provide mixed-mode transition (TS, traveling CF, stationary CF)
    - Relative importance of instabilities will vary with AoA
  - Boundary layer must be thick enough for off-body measurements
    - Mean and fluctuating components of velocity
  - Sufficient extent of laminar flow to measure instability growth
  - Body large enough to house embedded PIV system (or possibly LDV?) for non-intrusive BL measurements
  - Ability to change roughness enough to affect instability mechanism and transition location
  - Test multiple facilities for Re # and FS turbulence effect
    - Targeting facilities like 14x22 (M$\cong$0.2-0.3)
  - Desire to change FS turbulence (if possible)

Swept Wing/Body Configuration

- ## What is novel about this experiment?

  - Experiment with mixed-modes (stationary CF, traveling CF, TS) in a realistic wing/body configuration
    - Change instability modes through changes in angle of attack
    - Off-body non-intrusive measurements to help identify primary instability mechanism(s) and their relative importance
  - Characterization and (possibly) modification of roughness and/or FS turbulence
    - Modifications that affect transition front without causing bypass
  - BL measurements of beginning and end of transition (possibly)
  - Test in multiple facilities (changing FS turbulence and/or Re #)
  - Combining IR (global transition front) with off-body measurements

- ## What is added value?

  - Provide both transition location and instability mechanism(s) to transition modelers
  - Expand experimental database of roughness/FS turbulence effect on transition/instability mechanisms
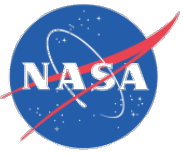
Input from the Community

- **Which measurements are most important?**
  - Flow measurements:
    - Transition front (IR/TSP)
    - Instability identification (frequency/wavelength/wave angle)
    - Instability amplitude
  - Surface/freestream characterization
    - Surface roughness
      - RMS
      - Wavelength spectra
    - Freestream turbulence
      - u', v', w'
      - Acoustic environment
      - Single point vs spanwise uniformity
      - Measurements upstream vs. BL edge
      - Empty tunnel vs tunnel+model
  - Anything else?

- **Other topics:**
  - Full-span vs semi-span – CFD perspectives?
  - Flow/test conditions
    - Incompressible
    - Reynolds # range
    - Variation of roughness/FS turbulence

- **What would you hope to get out of this test?**